# Teaming Up on Space Plants

**This week students, scientists, and astronauts will join forces to learn more about how plants grow in space.**

Marshall Space Flight Center

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**May 10, 2001** -- "When are we ever going to use this stuff?"

Teachers often struggle to give a satisfying answer when their students ask that perennial question. Because of a collaborative project with NASA, the answer for 600 science teachers around the U.S. is easy: "Right now!"

This week, astronauts on board the International Space Station (ISS) will activate the Advanced Astroculture™ plant growth chamber -- delivered to the ISS in April by the space shuttle Endeavour. A nutrient solution will inundate a bed of inorganic "soil," germinating the seeds buried there.

Meanwhile, back on Earth, thousands of students will begin growing their own batches of the plant, *Arabidopsis thaliana,* a flowering weed better known as thale cress. A comparison of the sprouting plants on Earth with those in Earth orbit will help students and scientists understand how plant lifecycles are affected by freefall.

**Above:** Students at Bangor Area Senior High School (Bangor, Pennsylvania) mix nutrient solutions that will be used to nourish their plants. The data on their plants' growth will be compared to measurements of plants grown on the International Space Station. Image courtesy Space Explorers, Inc.

"To be able to compare their experiment with one that's actually up in space -- this is one of those things that (my students) think is really neat and cool," said Terri Cole, an eighth grade science teacher participating in the project at Echols Middle School in Northport, Alabama. It engages students' interest in a way that standard textbook lessons do not.

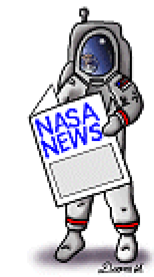
**Left:** The Space Shuttle Endeavour blasted off April 19, carrying the plant growth experiment to the ISS. The rack-mounted growth chamber will be switched on soon after installation onto the ISS last Friday. Sensors will monitor dozens of variables as the plants grow, and the data will be beamed down to the scientists and the students on the ground.

Such research is important to the future of space exploration, because plants will likely provide food and even replenish air and water supplies for future spacefarers. Long stays in space will require several generations of plants to grow reliably, so scientists must understand the seed-to-seed behavior of plants grown in space.

"You can read in a textbook about the lifecycle of a plant, and students may think it really isn't that big of a deal," said Eric Brunsell, one of the principal investigators for the project and director of education programs at Space Explorers, Inc. (SEI), the commercial company based in Green Bay, Wisconsin, that is developing the curriculum for the schools.

"But when you can watch a plant grow through those different lifecycles and know that a similar experiment is taking place on the International Space Station, it just adds another dimension of excitement to it," Brunsell said.

The students' plants will serve as a "control group" for the experiment -- a reference point of "normal" growth and reproduction against which the ISS plants can be compared. As the experiment progresses, students will see the differences between their plants and the plants in space by daily video and data updates available through the Web.






Zachary Upton, a 14-year-old student in Cole's science class, has one theory about how the ISS plants might differ.

"The plants on the Space Station might not fall over," speculates Upton. "Some of our flowers, the stems and stuff are falling over because of the pull of gravity. They might not do that in space."

To date, only two space-based experiments have managed to complete a whole lifecycle, notes Weijia Zhou, principal investigator for the project and director of the Wisconsin Center for Space Automation and Robotics (WCSAR). An experiment with wheat completed a lifecycle on Mir, but produced only empty seed heads (due to a significantly elevated ambient ethylene concentration). The other experiment successfully produced multi-generation seeds on Mir, but the experiment used a hardy species that's not representative of most food crops.

The current experiment's nearly 8-week stay aboard the ISS will allow enough time for one complete generation, ending with the production of new seeds. A host of measurements will be made as the plants grow, from stem height and seed count to temperature and $CO_2$ levels. This broad range of data should paint a clear picture of how *Arabidopsis* responds to the conditions in Earth orbit.

**Left:** Enclosed, environmentally controlled growth chambers, such as the one pictured here, were used by by the principal investigators to conduct ground-based experiments similar to the one aboard the ISS. Image courtesy WCSAR.

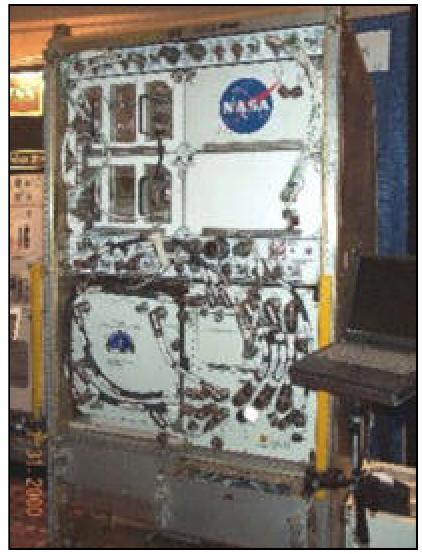
To understand the role of both genetics and environmental conditions in the experiment's outcome, WCSAR will conduct DNA and RNA analyses when the plants return to Earth. The plants grown on the ISS will be genetically compared to Earth-bound plants grown using an apparatus similar to the one on the Space Station. The ISS growth chamber is a totally enclosed, automated "greenhouse" developed by WCSAR and co-sponsored by NASA's Space Product Development Program at the Marshall Space Flight Center in Huntsville, Alabama.

Markedly different gene "expression" (i.e., activation of genes during plant functioning) in the ISS plants would mean that scientists will to need to look more closely at whether multiple generations of crops grown in space will remain viable.

*Arabidopsis thaliana* is a small, flowering plant widely used by researchers as a "model organism" for studying plant biology. It is a member of the *Brassica* family, which includes species such as cabbage, broccoli, cauliflower, and radish. It is an excellent subject for scientific research because of its rapid life cycle (about 6 weeks from seed to seed), easy cultivation in small spaces, prolific seed production, and fully-sequenced genome (a map of all its genes).

While molecular genetics is beyond the facilities of a typical science class, the use of DNA technology in the project will provide a vehicle for teaching basic genetics.

"We have a section that we deal with in biology that goes into genetics, so this is going to fit right into that," Cole said.



**Right:** Can you spot the "greenhouse" in this picture? The automated growth chamber developed by WCSAR occupies the top left quarter of this equipment rack. This picture gives an idea of how the plant-growth experiment on the ISS looks when mounted to the EXPRESS Rack in the U.S. Lab Module. Once installed, the unit will require only minimal attention from the ISS crew. Image courtesy WCSAR.

The collective store of data and video will continue to be used for a commercially-available science curriculum even after the ISS experiment returns to the ground. SEI will assemble the data into a Web-based curriculum called Orbital Laboratory, which will have versions geared for each grade from kindergarden through high school.

Data gathered by the students, which they will submit to on-line databases via the Web, will also contribute to the scientific outcome of the experiment by adding to the statistical robustness of the results.

"It's exciting to think that we're actually helping," said 14-year-old Kaitlyn Killion, one of Cole's students.

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### Web Links

Human Exploration and Development of Space -- The goal of NASA's Human Exploration and Development of Space (HEDS) Enterprise is to open the space frontier by exploring, using and enabling the development of space.

Spaceflight.NASA.gov -- The space agency's home page for human spaceflight.

Wisconsin Center for Space Automation and Robotics

Advanced Astroculture(TM) -- learn more about the plant growth chamber from the Wisconsin Center for Space Automation and Robotics.

Space Explorers, Inc. -- a commercial company based in Green Bay, Wisconsin, that is developing astroculture curriculum for schools.

Space Farming -- a distance learning module from Johnson Space Center

Leafy Green Astronauts -- *Science@NASA article*: NASA scientists are learning how to grow plants in space. Such far-out crops will eventually take their place alongside people, microbes and machines in self-contained habitats for astronauts.

Advanced Life Support definition -- explains why future life support systems for space exploration -- and possibly colonization! -- will use plants for food, oxygen generation, and possibly water purification. From NASA Kennedy Space Center.

NASA plant physiology research -- information about efforts to learn how to grow food crops in space

The role of *Arabidopsis* in plant science research -- information on *Arabidopsis* and why it has become the "model organism" for plant science research

*Arabidopsis* Information Resource -- access to a wide range of information on *Arabidopsis*, including genomic data

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